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(54) Grinding apparatus and method.

(57) Grinding apparatus (10) has a grinding disc (18) grinding a tool (14), both of which are washed with coolant from a hose (26). The coolant collects in a funnel (10) and enters a separation channel (40) comprising a labyrinthine path (46) over a magnetised floor plate (46).

Tungsten carbide is faintly responsive to a magnetic field and can be drawn out of suspension thereby.

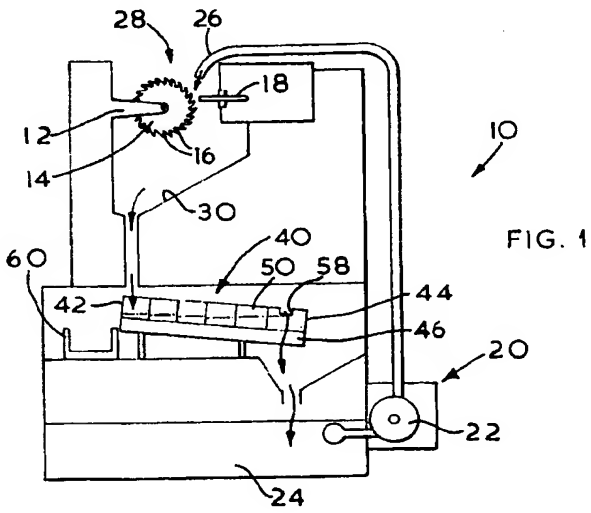

FIG. 1

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This invention relates to apparatus for grinding tungsten carbide tips of machine and other tools and particularly to a method of filtering the coolant employed in such apparatus.

In the manufacture of saw blades, for example, tungsten carbide tips are fixed by any suitable means (such as brazing) around the periphery of the blade to form the teeth thereon. While the tips will be supplied to the blade manufacturer with the appropriate shape within reasonable tolerances for the cutting operations they are eventually to perform, a final grinding operation is always required on them to ensure they are sharp and have the more accurate tolerances required in the final product.

The final grinding operation may be conducted in one or two stages depending on the particular saw blade being made and this is achieved in a grinding apparatus comprising means to hold the blade in a number of different angular positions to bring each tip in turn into proximity with one or more grinding wheels disposed in the apparatus and adapted to be moved across each tip to grind it in a particular plane. The grinding wheel is rotated by the apparatus to perform the grinding operation and comprises a hard composite material containing industrial diamond particles capable of grinding and removing material from the tungsten carbide tip.

In the process, the feed rates and relative speeds involved between the tip and the grinding wheel generate considerable frictional heat, not to mention very fine tungsten carbide dust. Thus a coolant is arranged to wash each tip as it is ground and the coolant comprises water and various known additives to assist the grinding process. Not least of these additives is a rust inhibitor to nullify the corrosive properties of water.

Environmental considerations alone are sufficient to prevent mere disposal of the coolant after use, but in any event the cost of the various additives employed would prohibit employing fresh coolant on a continuous basis. Thus each grinding apparatus further comprises a coolant sump into which used coolant drains and from which a pump collects the stored coolant for recycling to the grinding region of the apparatus.

The tungsten carbide dust generated during the grinding process is of course largely entrained and held in suspension in the coolant and because it is so fine it has no opportunity to settle out in any quantity in the sump before it is recycled with the coolant. Thus after only a matter of hours after a fresh charge of coolant is introduced to the grinding apparatus, the coolant becomes heavily contaminated with, primarily, tungsten carbide dust. Of course, dust is also generated from wear of the grinding wheel, but this accounts for less than 10% of the total dust generated.

This contamination leads to further problems. One problem is an environmental one in that some of the coolant at the point of grinding gets converted into a spray which enters and carries into the atmosphere the entrained dust. Apart from the mess which this dust creates as it settles in time on every horizontal surface in the vicinity of the apparatus, it may also be a health hazard to personnel operating the apparatus by virtue of the cobalt or other binder employed in the manufacture of tungsten carbide tips and grinding wheels. Thus in some jurisdictions, it is a requirement in such grinding apparatus to provide a screen and vacuum extraction apparatus in the grinding region to remove contaminated air from the region and away from the potential surroundings of the grinding apparatus operators. The need for this would be considerably reduced if clean coolant was employed all the time. A further problem is simply the contamination of the apparatus, and particularly its moving parts, with a fine, very hard dust which significantly reduces the working life of the apparatus.

It has, of course, long been appreciated the benefits which would accrue from employing clean solution, and an obvious answer is to filter the coolant before it is recycled. However the average size of particles suspended in the coolant is of the order of one micron and this necessitates the use of disposable ceramic filters and a pressure system to force the coolant through the filter. Such an arrangement is prohibitively expensive.

Another solution is to provide a large central coolant reservoir serving a multitude of grinding machines and into which the sump of each machine drains and from which fresh solution is drawn. The hope is that, given sufficient time and sufficiently still conditions, at least the larger heavier particles will have settled out of suspension before the coolant is re-employed. However, it is the small light particles which are particularly responsible for the problems outlined above, because it is they which get carried into the vapour spray and which tend to drift towards operators and deposit themselves in unwanted places. It is unlikely that the central reservoir can be rendered sufficiently large, given economic constraints, to ensure settling out of these small particles. Besides which, smaller particles may be held as a colloid rather than in suspension and in which case will never settle out.

Thus it is an object of the present invention, to provide a grinding apparatus which does not suffer from the afore-mentioned problems or which at least mitigates their effects.

The solution proposed by the present invention stems from the realisation that the commonly held view that tungsten carbide is not ferromagnetic, or at least not influenced by a magnetic field in the form in which it is employed in tool bit tips, is not entirely true and that, given sufficiently small particles and sufficiently still conditions, tungsten carbide will be attracted to the poles of a sufficiently strong magnet.

Thus in accordance with the present invention, there is provided grinding apparatus comprising

means for clamping a tool having a tungsten carbide tip to be ground by the apparatus, a rotatable grinding wheel adapted to grind said tip, coolant washing means adapted to direct coolant over the tip and wheel during grinding, coolant collection means to collect used coolant and entrained tungsten carbide particulate products generated during grinding, and a sump from which coolant is drawn by said washing means, characterised in that said coolant collection means deposits said coolant and entrained particles in the inlet of a separation channel, said channel having an outlet at a distance from said inlet and draining into said sump said channel being arranged at a slight inclination such that coolant trickles from inlet to outlet, a surface of said channel being magnetised, whereby said entrained particles are attracted by the magnetic field generated by said magnetised surface and are retained on said surface. The that coolant exiting said outlet preferably has less than 50% and ideally has less than 90%, the tungsten carbide particulate content as coolant entering the inlet.

It will of course be appreciated that the efficiency of the separation channel can be improved by various means. For example by increasing its length, which basically has the effect of increasing the residence time of coolant in the separation channel and therefore increases the probability of the particulate matter settling out under the influence of the magnetic field and being retained in the channel. Similarly, increasing the strength of the magnetic field has the same effect. The residence time of the coolant in the channel can also be increased simply by deepening the channel by, for example, having only a slight inclination of the channel from inlet to outlet of, say, less than five degrees from the horizontal and providing a weir at the outlet. However, care must be taken not to allow coolant, by virtue of deepening the channel for example, to be so far removed from the magnetic field that the strength of the field is not sufficient to draw the weakly attracted tungsten carbide particles onto said surface before the coolant spills over the weir.

Preferably means are provided enabling the channel to be cleared from time to time of the sludge of particulate matter which gathers on said surface.

It will be appreciated that many configurations of the separation channel within the ambit of the present invention are feasible, but a particularly preferred arrangement is a separation channel comprising a floor plate inclined from an inlet end to an outlet end thereof at an angle of less than ten degrees, and preferably at about five degrees, to the horizontal, and a labyrinth supported on said floor plate and comprising side containing walls having inwardly directed, interleaving walls disposed across the slope of said floor to define a labyrinthine path, said outlet comprising a weir formed in the side wall at the end of said path at the outlet end of the floor plate, a permanent magnet being disposed beneath said floor plate.

Preferably said floor plate is itself ferromagnetic. Preferably said labyrinth is not ferromagnetic and is not permanently fixed to said floor plate whereby said means enabling the channel to be cleared from time to time simply comprises lifting said labyrinth to leave the sludge on the plate from which it is easily cleared with a scraper or the like.

The invention is further described hereinafter, by way of example only, with reference to the accompanying drawings, in which:-

Figure 1 is a schematic side view of a grinding apparatus according to the invention; and

Figure 2 is a plan view of the separation channel of the apparatus of Figure 1.

In the drawings, a grinding apparatus 10 comprises an arm 12 to hold firmly in different angular positions a saw blade 14 having teeth 16 consisting of tungsten carbide tips or inserts brazed or otherwise fixed in shaped notches in the edge of the disc forming the blade 14.

The blade 14 is rotatable in the arm 12 to bring each tooth 16 in turn into position adjacent a grinding disc 18 rotationally mounted in the apparatus 10. The disc 18 is rotated at speed and, in a manner well known in the art, is moved through a grinding stroke past each tooth 16 to effect a grinding operation thereon. That operation may be on the outside edge of the tooth or on the side edges. However, none of this is the subject of the invention as it is quite conventional and can be changed without affecting the operation of the invention. For example, different surfaces of the teeth 16 could be ground, or indeed a different tool, such as a planer cutting blade edge or the like, might be employed, as long as the tool being ground is a tungsten carbide tipped tool.

In any event, to cool the tip and grinding wheel as the grinding operation is performed, coolant washing means 20 are provided comprising a pump 22 drawing coolant from a sump 24 and pouring it through a hose 26 over the disc 18 and blade 14 where they meet in a grinding region 28 of the apparatus 10.

After performing its cooling, lubricating, washing function, most of the coolant finds its way to a funnel-like coolant collection means 30, but a small proportion is sprayed and misted by the heat and movement pertaining in the grinding region 28. If the coolant is clean when it washes the grinding region, then the spray generated is not so much of a problem, because then the contamination by entrained particles is not at a high level. If, however, the coolant collected in funnel 30 is merely returned directly to sump 24 for recycling, it soon becomes heavily contaminated with particles and in which case the spray likewise is heavily contaminated and this causes numerous problems as described earlier.

Thus the present invention provides a separation channel 40, into an inlet end 42 of which the coolant collected in funnel 30 drains. Only after passing along

the channel 40 does the coolant exit from an outlet end 44 of the channel 40 and find its way into sump 24.

Figure 2 shows a plan view of the channel 40 which comprises a floor plate 46 and labyrinth 48 consisting of containing side walls 50 and interleaving walls 52, which between them define a labyrinthine path 54.

The floor plate 46 is inclined downwardly from inlet end 42 to outlet end 44 at an angle of about five degrees to the horizontal. The funnel collection means 30 opens above a first blind end 56 of the path 54 at the inlet end 42 of the channel 40. Thus coolant dropping into the inlet 56 trickles down the path 46 until it reaches an outlet 58 formed in the side wall 50 at the other blind end 58 of the path 54. The outlet 58 is in the form of a weir so that at this end of the channel the coolant will be moving more slowly than at the other end.

The floor plate 46 comprises a magnet, or indeed a collection of smaller magnets arranged in an array inside a containing box forming said plate 46. The exact arrangement of magnets has not at this stage been analysed and may require some experimentation in this respect to achieve optimum results.

Tungsten carbide is faintly magnetic, contrary to popular conceptions which treat it as a non-magnetic substance for all material purposes. With particles as fine as are generated in normal grinding operations (of the order of one micron diameter) and with a labyrinth path 46 of about 1.5 metres long over an area of about one square metre and with an average depth along the path of about 20mm giving a total volume of coolant in the channel 40 of about 600 ml and with a flow rate of about half of one litre per minute, we have found that with a magnet having a magnetic induction of 3900 Gauss that more than 90% of particles of tungsten carbide in the coolant entering the inlet 56 are absent from the coolant overflowing the weir at the outlet 58.

After a period of some time of continuous operation and repeated grinding of successive teeth on successive blades 14, a sludge of tungsten carbide forms on the floor plate 46. If the labyrinth 50 merely seats on the plate 46 and is not itself magnetic (or indeed of ferromagnetic material so that it becomes magnetised) then it can be removed from time to time so that the sludge can simply be scraped off the plate 46 into a receptacle 60 provided for this purpose.

The sludge has significant scrap value and thus is collected for optional drying and resale.

Claims

1. Grinding apparatus (10) comprising means (12) for clamping a tool (14) having a tungsten carbide tip (16) to be ground by the apparatus, a rotatable grinding wheel (18) adapted to grind said tip, coolant washing means (20,22,16) adapted to direct coolant over the tip and wheel during grinding, coolant collection means (30) to collect used coolant and entrained tungsten carbide particulate products generated during grinding, and a sump (24) from which coolant is drawn by said washing means, characterised in that said coolant collection means deposits said coolant and entrained particles in the inlet (56) of a separation channel(40), said channel having an outlet (58) at a distance from said inlet and draining into said sump, said channel being arranged at a slight inclination such that coolant trickles from inlet to outlet, a surface of said channel being magnetised, whereby said entrained particles are attracted by the magnetic field generated by said magnetised surface and are retained on said surface.

2. Apparatus as claimed in Claim 1, characterised in that said magnetised surface is the floor (46) of said channel.

3. Apparatus as claimed in Claim 2, characterised in that said floor of the channel comprises one or more permanent magnets.

4. Apparatus as claimed in any preceding claim in which said channel is inclined to the horizontal from inlet to outlet by an angle less than five degrees.

5. Apparatus as claimed in any preceding claim, characterised in that said outlet comprises a weir (58) at the outlet end of the channel.

6. Apparatus as claimed in any preceding claim, characterised in that it further comprises means enabling the channel to be cleared from time to time of tungsten carbide sludge which is gathered on said surface.

7. Apparatus as claimed in any preceding claim, characterised in that said separation channel comprises a floor plate (46) inclined from an inlet end to an outlet end thereof, and a labyrinth supported on said floor plate and comprising side containing walls (50) having inwardly directed, interleaving walls (52) disposed across the slope of said floor to define a labyrinthine path.

8. Apparatus as claimed in Claim 7, characterised in that said floor plate is itself ferromagnetic.

9. Apparatus as claimed in Claims 6 and 7 or in Claims 6 and 8 characterised in that said labyrinth is not ferromagnetic and is not permanently

fixed to said floor plate whereby said means enabling the channel to be cleared from time to time comprises lifting said labyrinth to leave the sludge on the plate.

10. A method of filtering coolant employed in grinding apparatus used to grind tungsten carbide bodies, characterised in that said method comprises the step of passing the coolant over a magnetised surface so that tungsten carbide particles entrained in the coolant in a grinding region of the apparatus are deposited on said surface.

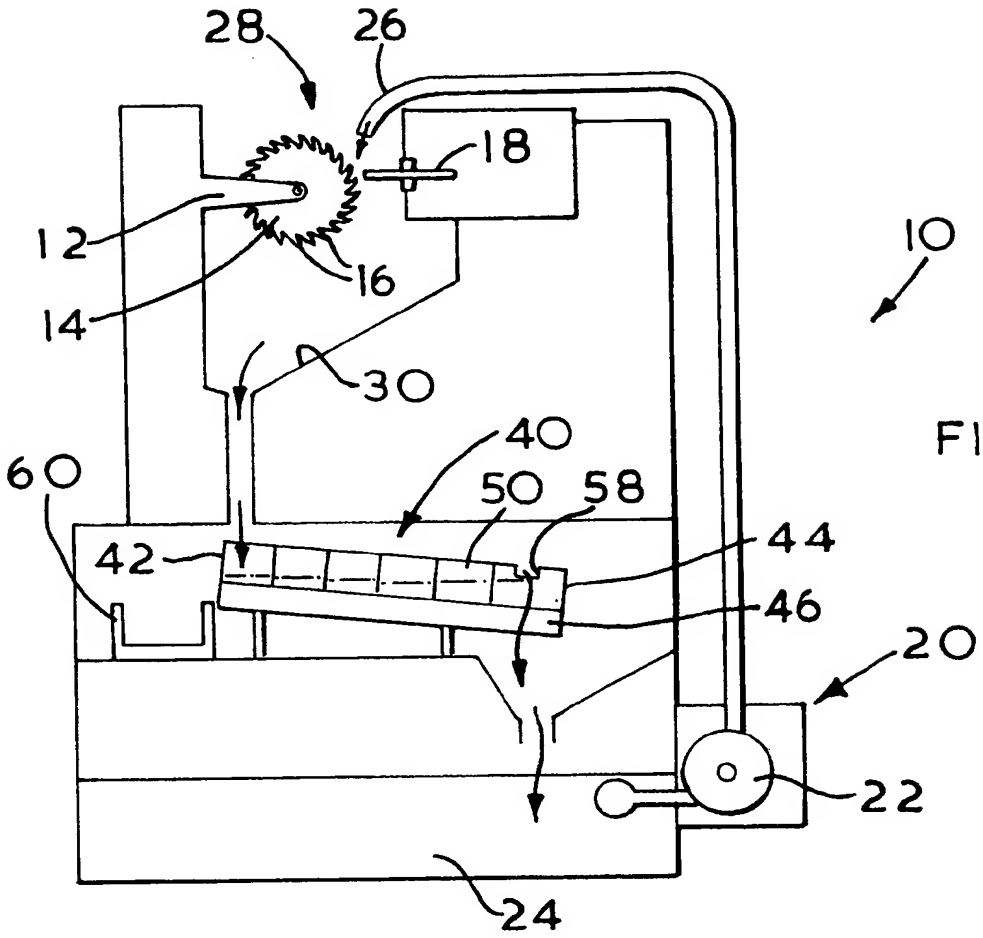

FIG. 1

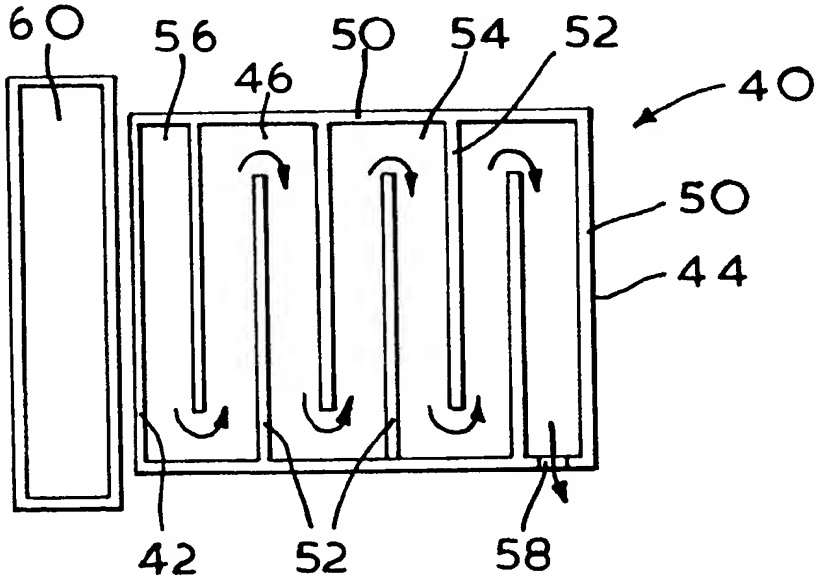

FIG. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 92 30 9078

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	US-A-4 186 529 (HUFFMANN) * abstract * * column 15, line 41 - line 44 * * column 8, line 57 - line 64; figure 9 *	1-10	B24B55/03 B24B55/12 B03C1/08 B23Q11/10
Y A	DE-B-1 034 306 (NAGEL) * the whole document *	1-10 2-6	
A	FR-A-2 479 059 (INOUE-JAPAX) * claims; figures *	7-9	
A	US-A-2 622 699 (MILLS)		
A	PATENT ABSTRACTS OF JAPAN vol. 6, no. 69 (M-125)(947) 30 April 1982 & JP-A-57 8 073 (HITACHI) 16 January 1982 * abstract *		
A	PATENT ABSTRACTS OF JAPAN vol. 13, no. 36 (M-790)(3384) 26 January 1989 & JP-A-63 245 350 (TRINITY) 12 October 1988 * abstract *		TECHNICAL FIELDS SEARCHED (Int. Cl.5) B24B B03C B23Q F16N

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	27 JANUARY 1993	ESCHBACH D.P.M.

CATEGORY OF CITED DOCUMENTS

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